1904
D93

DURLAND

# Burnt Clay for Concrete

Civil Engineering
B. S.
1904

UNIVERSITY
OF
ILL. LIBRARY

UNIVERSITY OF ILLINOIS
LIBRARY

BOOK CLASS VOLUME
1904 D93

767
D7
1904

# BURNT CLAY FOR CONCRETE

...BY...

Clyde Earl Durland

---

THESIS FOR THE DEGREE OF BACHELOR OF SCIENCE
IN CIVIL ENGINEERING

---

COLLEGE OF ENGINEERING
UNIVERSITY OF ILLINOIS
PRESENTED JUNE, 1904

6004 K8L

UNIVERSITY OF ILLINOIS

May 27, 1904 190

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

CLYDE EARL DURLAND

ENTITLED BURNT CLAY FOR CONCRETE

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Civil Engineering.

Ira O Baker

HEAD OF DEPARTMENT OF Civil Engineering

66181

1904
D93



# BURNT CLAY FOR CONCRETE.

The object of this thesis is to investigate the comparative merits of burnt clay and broken stone for use as an aggregate in concrete. While it was not thought that concrete made with burnt clay would have the strength of that made with broken stone, the question of the comparative cost of the two materials and the relative strength of concrete made of them, was deemed worthy of investigation. The facts that concrete is coming more and more into general use, and that the price and demand for broken stone are gradually increasing, add con-

Digitized by the Internet Archive
in 2013

http://archive.org/details/burntclayforconc00durl

siderably to the importance of this investigation.

It is proposed to determine the crushing strength of cubes and the transverse strength of beams made of concrete in which burnt clay is the aggregate, and also to determine the same for similar check samples made of concrete in which broken stone is the aggregate, care being taken to have all details of the experiments exactly alike in both cases. It is also proposed to determine, as far as possible, the relative cost of the burnt clay and of the broken stone.

## THE MATERIALS.

The cement in all cases was Chicago A A portland. The sand was obtained from the Wabash River, near Attica, Ind, and was thoroughly washed at the pit. It contained but few fine grains. The broken stone was a coarse grained limestone from Kankakee, Ill. This stone is considered to be of very good quality for concrete.

The burnt clay was obtained from the Wabash R.R. Co., Through the kindness of Mr. H. M. Snyder, Assistant Engineer of that system. The clay was burned at the company's plant at Keytesville, Mo. For a description of this plant and of

the method of burning, see Engineering News, March 12, 1900, page 312.

## TABLE 1.

Physical Properties of the Burnt Clay and of the Broken Stone.

| Material | Color | Fineness | | Absorption Water per cent | Specific Gravity | Weight per cu. yard Pounds | Relative Weight |
|---|---|---|---|---|---|---|---|
| | | Per cent caught on a 1-inch ring | Per cent caught on a 1/2 inch ring | | | | |
| Clay | Red | 66 | 97 | 11.1 | 1.702 | 106.2 | 75.3 |
| Stone | Gray | 47 | 91 | 0 | 2.260 | 141.0 | 100.0 |

## MAKING THE CUBES AND BEAMS.

The concrete was mixed in the proportions: 1 part cement, 3 parts sand, and 5 parts aggregate. This proportion is frequently used in actual work. The sand and cement were thoroughly mixed dry, after which the aggregate and water (about 12 per cent by volume) were

added, and the entire mass was thoroughly turned. The concrete was of such consistency that when thoroughly tamped into the molds, water flushed to the surface.

The molds were of 2-inch by 6-inch oak, so made as to have a capacity for three 6-inch cubes each, or by removing two partitions, for one 6-inch by 6-inch by 22-inch beam. The molds were open at top and bottom. The sides, which were grooved to receive the partitions, were bolted together at the ends.

Enough concrete was mixed at a time to make five cubes or three beams. In making the cubes, the concrete was put into the molds in three

equal layers. Each layer of each cube was struck fifty blows with a 12-pound tamper whose face was 2½ inches square. The concrete for the beams was also put into place in three equal layers, each of which was given one hundred and fifty blows with the tamper. The specimens were allowed to remain in the molds about forty-eight hours, and were then (with two exceptions, see pages 11 & 12) taken out and placed under water.

## TEST OF STRENGTH.

All specimens were tested on a Philadelphia Machine in the University Testing Laboratory. They were placed in the machine in the

in the position in which they were molded, i.e., with the layers horizontal. The bearing surfaces were coated with enough quick-setting plaster of Paris to give a smooth, even bearing. After the plaster was applied it was allowed to set under pressure in the machine. The beams were tested, supported at the ends. Rocker supports were used for one set of beams and straight supports for the other. The supports were placed eighteen inches apart and the pressure was applied on top, half way between the supports.

# TABLE 2.

## Crushing Strength of Cubes.

| Ref. No. | Aggregate. | Scale Beam Reading Pounds. | Strength lbs. per sq. in. | Relative Strength. | Remarks. |
|---|---|---|---|---|---|
| | | Age: 7 Days. | | | |
| 1 | Clay | 37000 | 1030 | | |
| 2 | " | 36000 | 1000 | | |
| 3 | " | 38000 | 1075 | | |
| 4 | " | 39500 | 1100 | | |
| 5 | " | 44200 | 1230 | | |
| | Average | | 1087 | 59.8 | |
| 6 | Stone | 67000 | 1860 | | |
| 7 | " | 82500 | 2290 | | |
| 8 | " | 82800 | 2300 | | |
| 9 | " | 61800 | 1710 | | |
| 10 | " | 69100 | 1920 | | |
| | Average | | 1860 | 100 | |

# TABLE 2.

## Crushing Strength of Cubes.

| Ref. No. | Aggregate. | Scale Beam Reading Pounds. | Strength lbs. per sq. in | Relative Strength. | Remarks. |
|---|---|---|---|---|---|
| | | Age: 28 Days. | | | |
| 11 | Clay | 52700 | 1460 | | In this case |
| 12 | " | 58900 | 1640 | | the clay was |
| 13 | " | 53800 | 1490 | | thoroughly wet |
| 14 | " | 57000 | 1580 | | before mixing. |
| 15 | " | 43300 | 1200 | 76.1 | |
| | Average | | 1474 | | |
| 16 | Stone | 67700 | 1880 | | |
| 17 | " | 68000 | 1890 | | |
| 18 | " | 63500 | 1760 | | |
| 19 | " | 71000 | 1970 | | |
| 20 | " | 78600 | 2180 | 100 | |
| | Average | | 1936 | | |

# TABLE 2.

## Crushing Strength of Cubes.

| Ref. No. | Aggregate | Scale Beam Reading Pounds. | Strength lbs. per sq. in. | Relative Strength | Remarks. |
|---|---|---|---|---|---|
| | | Age : 63 Days. | | | |
| 21 | Clay | 69100 | 1920 | | |
| 22 | " | 58300 | 1620 | | |
| 23 | " | 61100 | 1700 | | |
| 24 | " | 55400 | 1540 | | |
| 25 | " | 60500 | 1680 | 76.0 | |
| | Average | | 1692 | | |
| 26 | Stone | 78000 | 2170 | | |
| 27 | " | 87300 | 2420 | | |
| 28 | " | 81800 | 2270 | | |
| 29 | " | 73600 | 2040 | | |
| 30 | " | 79500 | 2210 | 100 | |
| | Average | | 2225 | | |

# TABLE 2.

## Crushing Strength of Cubes.

| Ref. No. | Aggregate. | Scale Beam Reading Pounds. | Strength lbs. per sq. in. | Relative Strength. | Remarks. |
|---|---|---|---|---|---|
| | | Age: 91 Days. | | | |
| 31 | Clay | 62000 | 1720 | | These cubes |
| 32 | " | 62200 | 1730 | | were not put in |
| 33 | " | 70500 | 1960 | | water, but were |
| 34 | " | 68200 | 1890 | | allowed to set |
| 35 | " | 76000 | 2110 | 65.5 | out of doors in |
| | Average | | 1882 | | the weather. |
| 36 | Stone | 101000 | 2800 | | They failed |
| 37 | " | 106000 | 2940 | | first around |
| 38 | " | 102500 | 2850 | | the edges. |
| 39 | " | 92000 | 2550 | | |
| 40 | " | 116000 | 3220 | 100 | |
| | Average | | 2872 | | |

# TABLE 3.

## Transverse Strength of Beams.

| Ref. No. | Aggregate. | Scale Beam Reading Pounds. | Strength lbs. per sq. in. | Relative Strength | Remarks. |
|---|---|---|---|---|---|
| | | Age: 63 Days. | | | |
| 1 | Clay | 4500 | 125 | | These beams |
| 2 | " | 5170 | 144 | | were not put in |
| 3 | " | 4600 | 128 | 110.9 | water, but were |
| | Average | | 132 | | allowed to set |
| 4 | Stone | 4000 | 111 | | out of doors in |
| 5 | " | 5000 | 139 | | the weather. They |
| 6 | " | 3800 | 106 | 100 | were tested on |
| | Average | | 119 | | rocker supports. |
| | | Age: 91 Days. | | | |
| 7 | Clay | 4360 | 121 | | These beams |
| 8 | " | 3700 | 103 | | were tested on |

# TABLE 3.

## Transverse Strength of Beams.

| Ref. No. | Aggregate | Scale Beam Reading Pounds. | Strength lbs. per sq. in. | Relative Strength | Remarks. |
|---|---|---|---|---|---|
| 9 | Clay | 4000 | 111 | 94.1 | straight supports |
| | Average | | 112 | | which are not |
| 10 | Stone | 4240 | 118 | | thought to be as |
| 11 | " | 3880 | 108 | | satisfactory as |
| 12 | " | 4860 | 132 | 100 | the rocker type. |
| | Average | | 119 | | |

## COST OF THE AGGREGATE.

In regard to the cost of the two materials, it was found that the broken stone, at present, costs from two to three times as much as the burnt clay. The Wabash R.R. Co. prepares the clay, and loads it ready for shipment, at a cost of from thirty (30) to thirty-five (35) cents per cubic yard. The cost of a good quality of crushed limestone is from sixty (60) cents to one (1) dollar per cubic yard, in car load lots, f. o. b. cars at the quarry.

## CONCLUSION.

While burnt clay does not make

as strong a concrete as does the broken stone, its comparatively low cost, together with the fair amount of strength which it has might warrant its use in some cases. A few of the uses for which the writer would recommend burnt clay for concrete are; ① brick pavement foundations, ② rail-road culverts and small abutments in prairie country, and ③ concrete floors for fire-proof buildings, its light weight being a particular advantage in this case.

UNIVERSITY OF ILLINOIS-URBANA
3 0112 086824221